The Steering Committee responded to this criticism by stating bluntly, "There are no economic barriers created by the new Project 25 standards."[27]

The Transcrypt report responds similarly to this criticism. Referring to these major manufacturers, the report states: "Any of these companies could manufacture the communication equipment defined by the Project 25 standard if and when they choose to."[28] That is not quite true. They first need to get a license from Motorola. The real question is why are these firms absent from the market? After the SPR study was prepared, Nokia, one of the major firms mentioned in the SPR study as not entering the U.S. public safety market, stated publicly that they stayed out of this market because of the anticompetitive effects of Project 25 and anticompetitive behavior of the leading vendor in this market. An article in *Land Mobile Radio News*, headlined "Nokia Won't Enter U.S. SMR Market" said:

> **Because of Motorola's stranglehold on the U.S. public safety market through the recently adopted APCO 25 standard, Nokia has make the decision to stay out of the U.S. private radio market as a whole.**[29]

Transcrypt asks rhetorically, "How is it that smaller companies such as Bendix King, E.F. Johnson, and Transcrypt have found the funds to enter . . . ?"[30]

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[27] Steering Committee Comments, p. 15.

[28] Transcrypt report, p. 12.

[29] *Land Mobile Radio News*, October 13, 1995, p. 7, emphasis added. SPR had no contact with Nokia nor was SPR aware of this statement until SPR staff read the statement in the press. A similar article appeared in *Communications Today*, October 4, 1995, p. 5.

[30] Transcrypt report, p. 13.

We can answer this question for Transcrypt. Transcrypt is in the process of a public stock offering and has consequently made public substantial information about their business activities. Examining Transcrypt's SEC S-1 Registration Statement we find the following statement:

> The Company's objective is to maintain its position as a leader in the market for wireless voice security products used in LMRs and cellular telephones, while building on its core technological competencies to enter new markets for secure voice and data security products. The Company's strategy to accomplish this objective include developing new products based on existing core technologies, offering complete secure products solutions, **fostering key strategic relationships, such as the Company's relationship with Motorola**, and exploring strategic acquisitions.[31]

The first risk factor Transcrypt lists in their S-1 is their reliance on Motorola. They say:

> **Motorola is the Company's largest customer and a key supplier**.[32]

The exhibits to the S-1 contain redacted versions of contracts between Motorola and Transcrypt. Exhibit 10.8 is entitled OEM Agreement (APCO 25). OEM is an acronym for Original Equipment Manufacturer. The term is used in the electronics and computer industries to refer to firms that purchase systems or subsystems, put their own label on them, and sell them as original

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[31] SEC Form S-1, Transcrypt International, Inc., October 1996, p. 4, emphasis supplied.

[32] S-1, p. 7, emphasis added.

equipment.[33] That agreement, dated August 2, 1994, begins with several interesting recitals which put the relationship between Motorola and Transcrypt into perspective. These include:

> WHEREAS, MOTOROLA and Transcrypt have committed to support Project 25 and to be active advocates therefore in APCO and Telecommunications Industry Association ("TIA") proceedings, as well as the marketplace; and
>
> WHEREAS, MOTOROLA has designed and is manufacturing an APCO 25 compliant digital trunked two-way land mobile radio system known as ASTRO(R), and is in rightful possession of certain proprietary rights in the valuable technology related thereto; and
>
> WHEREAS, Transcrypt is particularly qualified or otherwise particularly suited to purchase certain ASTRO(R) Products from MOTOROLA for resale and MOTOROLA desires to sell such products to Transcrypt, . . .[34]

An amendment to the OEM license agreement gives Transcrypt access to certain Motorola encryption technology. Motorola also has the right to immediately terminate the amended portions of the agreement if control of Transcrypt passes to any of several companies including AT&T, Lucent, or any of several other major communications firms.[35] Transcrypt's SEC exhibit

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[33] A dictionary at http://www.sandybay.com/pc-web/OEM.htm contains the following definitions for the term OEM:

> (n) Stands for original equipment manufacturer, which is a misleading term for a company that has a special relationship with computer producers. OEMs buy computers in bulk and customize them for a particular application. They then sell the customized computer under their own name. The term is really a misnomer because OEMs are not the original manufacturers — they are the customizers. Another term for OEM is VAR (value-added reseller).
>
> (v) To provide equipment to another company, an OEM, which customizes and markets the equipment.

[34] Transcrypt S-1, Exhibit 10.8, p. 1.

[35] Transcrypt S-1, Exhibit 10.7, p. 6.

shows in black and white that Motorola wants to be able to prevent firms such as Lucent Technologies from getting the deal Motorola is giving to Transcrypt. Would Motorola need such controls if Transcrypt were a real competitor?

Transcrypt has also submitted a handheld radio for FCC equipment authorization. The Basic Technical Manual submitted with that radio contains the following acknowledgment: "Due to the use of several sub-assemblies from Motorola in this radio, the descriptions covering the Transceiver Board and ADSIC operation have been liberally copied from the Motorola ASTRO service manual."[36]

The evidence appears clear that Transcrypt is in the Project 25 business not as a manufacturer and designer, as the term is normally conceived, but rather as a reseller of Motorola radio equipment. There is nothing wrong with that. But, it is wrong for Transcrypt and the Steering Committee to present Transcrypt as an independent manufacturer selling in competition with Motorola. Rather, Transcrypt is one of Motorola's many product distribution channels.

The Steering Committee claims that "the public safety community will be able to choose from at least three Project 25 system suppliers (Motorola, RELM, and EF Johnson/RACAL), up to six subscriber unit suppliers (Transcrypt International, Stanilite, RELM, EF Johnson/RACAL, Garmin, and Motorola) and five repeater/base station suppliers (Daniels, Stanilite, EF

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[36] FCC Equipment Authorization File 31010/EQU 17.9, granted May 23, 1996.

Johnson/RACAL, RELM and Motorola)."[37] Removing duplications, the Steering Committee offers a list of six Project 25 suppliers besides Motorola. They are Daniels, EF Johnson/RACAL, Garmin, RELM, Stanilite, and Transcrypt. We have already examined Transcrypt. Let us look at each of the others.

Daniels Electronics Ltd. is a small firm in British Columbia, Canada, specializing in fitting radio base stations with solar power cells for operating in remote locations. We estimate it has about 50 employees. Providing such complements to Motorola base stations can be valuable, but it is not competition. Daniels clearly lacks the scale to take Motorola on in broad head-to-head competition for major public safety radio communication systems.

EF Johnson is a well-known name in North American land mobile communications, having been in business since 1923. There have been recurring rumors in recent years that the firm is under substantial financial stress. EF Johnson sold its components division in early 1996. We believe that it probably has several hundred employees, but is not in strong financial shape. The trade press reported that EF Johnson plans to work with Racal Electronics Group to produce an APCO 25 version of an existing Racal radio.[38] Racal, EF Johnson's partner in Project 25, is a major British defense electronics and communications manufacturer. Of all the firms mentioned as

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[37] Steering Committee Comments, p. 11.

[38] *Land Mobile Radio News,* August 16, 1996.

potential suppliers of Project 25 equipment, Racal probably both is the largest and has the greatest depth of technological and manufacturing skills.

Garmin is a manufacturer of GPS equipment. It is owned by Garmin Corporation of Taiwan. We know of no land mobile products it provides (other than GPS systems and components). We believe that it has a few hundred employees.

RELM is the new name for the former Regency Electronics. This firm has been a supplier of land mobile equipment for several years and has a subsidiary, Bendix-King, active in Project 25. We believe that it has a few hundred employees.

Stanilite is an Australian information technology firm with about 100 employees in the telecommunications area. After continuing losses, it went into receivership some months ago and was sold to Australian Defense Industries (ADI). ADI is owned by the Australian government.[39] The trade press reports that Stanilite has slipped from the timetable it announced earlier in 1996 and that "the company has no immediate plans to manufacture trunking subscriber devices, rather it plans to sell those from another vendor,"[40] That same story goes on to say that Stanilite's U.S. office is not currently operating and that the U.S. sales effort will be run from

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[39] *Jane's Defense Weekly*, July 24, 1996.

[40] *Land Mobile Radio News*, August 9, 1996.

Sydney, Australia. The evidence indicates that Stanilite is, at best a weak competitor, under great financial and organizational stress.

The six firms that the Steering Committee holds up as Project 25 competitors are all relatively small. At least one of them is properly classified as a Motorola reseller rather than as a competitive manufacturer and another is a specialist in solar-powered base stations — well-positioned to enhance or add value to Motorola equipment, but not to design and build a Project 25 base station from scratch. Others of the competitors appear to be in shaky financial shape. In contrast to these firms, Motorola is a profitable giant. Motorola had sales of $27 billion in 1995, after-tax profits of about $1.8 billion, and 142,000 employees.[41] The firms described in the SPR report as not being attracted by Project 25 into the land mobile market include Hughes, Nokia, and AT&T (Lucent Technologies); all are also giants each with billions of dollars of sales each year.

As Nokia's decision to stay out of the private land mobile business makes clear, the Project 25 standard has impeded rather than facilitated the entry of new, major suppliers into the public safety land mobile market. This was the essence of the criticism expressed in the 1995 SPR study. Today, it is even easier to see the truth of this proposition than it was in 1995. Project 25 could have developed a standard making it easier for new entrants to gain a foothold in the public safety land mobile market. But, it did not. The Steering Committee's Comments ask why a firm

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[41] See http://www.mot.com/General/Financial/Annual_Report/1995/lite/finhighlights.html.

would enter the public safety land mobile market "for 3% or less of the business."[42] Of course, if the standard were designed to facilitate competition, the new entrants could fight for an arbitrary large share of the market.

B. Availability of Multi-band Radios

The SPR study observed that Project 25 does nothing to deal with the fundamental interoperability problem flowing out of the multiple-band structure of land mobile frequency allocations.

The Motorola report disputes this observation and states that "there are already multi-band radios operating across the bands of public safety."[43]

The question is not whether it is *technically possible* to build such radios — surely it is — but whether such radios can be *affordable and effective* today for use in public safety communications. The PSWAC Final Report states: "Interoperability between Public Safety users in the past has been hampered by an interdependent set of factors that includes widely dispersed and **fragmented spectrum allocations that cannot be covered by multiband radios**, nonstandard frequency spacings and system access methods, and the lack of clear, nationwide

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[42] Steering Committee Comments, p. 15.

[43] Motorola report, p. 8.

channels allocated solely for interoperability."[44] Participants in the PSWAC process can clearly recall Wayne Leland, Motorola corporate vice-president, making a strong statement at a meeting of a PSWAC subcommittee that multi-band radios were uneconomic and impractical today. The APCO 25 Steering Committee in its comments in this docket asks the FCC to find funding for the development of economical multiple band technologies.[45] Steering Committee member John Powell, in his separate personal comments in this proceeding, offers detail on multi-band radios. He provides a review of the problems and possibilities of multi-band radios and states: "Manufacturers have indicated it would be extremely difficult to build a dual-band radio with one of the bands operating at 800 MHz; a major problem being dual-band antenna design."[46] Perhaps the most telling argument against the position in the Motorola report comes from Motorola's Comments in these proceedings.[47] Motorola tells the FCC:

> There is no single solution to interoperability problems; rather, interoperability is a goal only achievable by policy action on several fronts. First, interoperability can be enhanced by addressing the fragmentation and scarcity of spectrum. Nationwide, public safety agencies at all levels use a total of ten radio bands that range from 30 MHz to over 800 MHz. **No single commercial grade radio is capable of operating in all these bands.**

To recapitulate, the PSWAC Final Report, John Powell, the Steering Committee, Motorola Vice President Wayne Leland, and Motorola's own comments all support the view expressed in the

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[44] PSWAC Final Report, Section 2.1.4, p. 19, emphasis added.

[45] Steering Committee Comments, p. 22.

[46] Comments of John S. Powell, WT Docket 96-86, p. 10.

[47] Comments of Motorola, Inc., WT Docket No. 96-86, October 21, 1996, p. 8-9, emphasis added.

SPR study that the multiple bands used for public safety radio pose a substantial barrier to effective interoperability. The contrary view in the Motorola report and the implication that multi-band radios can solve this problem today is untenable. One must conclude that Project 25 is not a magic elixir that will allow a fire truck on UHF to talk to a dispatcher on 800 MHz.

C. Incentive Problems When Upgrading

The SPR study observed that the channel-splitting approach used by Project 25 had two shortcomings when compared with more modern technologies: (1) it raises costs, and (2) the freed-up spectrum is returned to the FCC pool and may be licensed to others, not returned to the user who implements the "efficient technology."

The Transcrypt report strongly objects to the second concern and the philosophy it expresses. The philosophy is nothing more than recognizing that the right to use a specific portion of the radio spectrum is a valuable right and that a rational user should not be expected to surrender such a valuable right unwittingly. We still believe that Project 25 creates an incentive problem that will hamper its adoption. Investment in a Project 25 radio may free up spectrum for licensing to other users.[48] Such new users may be other public safety agencies or they may not —

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[48] There is at least one way for an agency to get around this incentive problem. Because Project 25 radios are backwards compatible with older equipment, agencies can continue to operate 25 kHz FM radios on their channels. Such continued operation precludes reassignment of the 6.25 kHz splinter channels that are created on either side of the 12.5 kHz Project 25 channel. Of course, if an agency behaves this way, we see the worst of both possible worlds. There is no increase in spectrum efficiency for the agency and there is no release of spectrum for other agencies. Nevertheless, this appears to be a likely outcome given the combination of the

(continued...)

depending upon the band and the state of the FCC rules at the time the Project 25 equipment is put in place. Other system designs, TDMA being one, have the advantage of delivering the benefits of increased spectrum efficiency and expanded capacity to the agency that makes the investment in the hardware. If spectrum were readily available and of little or no value, then this difference of whether the implementing user or some other user gets the benefits of improved spectrum efficiency would make little practical difference.[49]

V. Conclusions

The conclusions regarding Project 25 limitations set forth in the 1995 SPR, study *A Need to be Heard: Will Project 25 Meet Public Safety Communications Needs in 1995 and Beyond?,* are still valid. Furthermore, the comments of the APCO Project 25 Steering Committee, including the reports by Transcrypt and Motorola, do not provide any valid basis for disputing the conclusions of the 1995 SPR study when they were made or today.

These identified shortcomings in the Project 25 standard appear to grow from two roots. First, the Project 25 process did not take sufficient account of the problem of control of IPRs by the public safety land mobile radio market's dominant supplier. Second, the Project 25 design was not optimized for spectrum efficiency in urban areas. The channel-splitting approach used by

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[48](...continued)
FCC's Refarming Rules, Project 25 technology, and the incentives facing public agencies.

[49] Of course, if spectrum were readily available, then we would not need to worry about spectrum efficient technology and we would not have any difficulty in finding adequate spectrum for public safety communications.

Project 25 generates spectrum efficiency gains very slowly if at all. Any spectrum efficiency gains will come only after a large fraction of users convert to similar narrowband technologies. Further, the ultimate efficiency of Project 25, Phase 1, 12.5 kHz per active conversation, is well below today's state-of-the-art. TETRA, a TDMA system designed for public safety applications, packs four voice channels into 25 kHz and is an irrefutable proof that it is possible today to build a system providing immediate spectrum gains twice what Project 25, Phase 1 can provide in the most favorable long-run and four times what Project 25 can provide in this century. Furthermore it is clearly arguable that Project 25, Phase 2, something that will not come for years to come, with 6.25 kHz channels as now envisioned in refarming will never actually provide efficiency as good as TETRA-like systems can provide today.

In its NPRM, the Commission asked for comments on whether Project 25 will further restrict competition in a market already concentrated, not contribute to spectrum efficiency, and not move public safety closer to interoperability.[50] The discussion above offers abundant answers to each of these questions. Project 25 will restrict competition — indeed, by excluding Nokia, has already reduced competition. Project 25 appears highly unlikely to contribute to spectrum efficiency in the short run. Project 25, Phase 1 lacks the efficiency needed in the long run. Project 25 will not appreciably aid interoperability — the major problems of interoperability are not addressed by Project 25.

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[50] NPRM, paragraph 100.

A public safety user agency, contemplating purchasing a Project 25 compliant radio system should ask itself the following questions:

- Will a Project 25 radio expand my system capacity on my currently licensed channels?
- Will sufficiently many agencies ultimately adopt Project 25 that I will gain any advantages from having purchased Project 25 equipment?
- Will the major agencies in spectrum-starved urban areas near me who need added capacity now adopt Project 25?
- Will I be able to order and install network upgrades from any source other than the original system vendor?
- Will I be able to order mobile and portables from firms that are true competitors, not Motorola resellers or OEMs?
- Do the benefits of a Project 25 purchase outweigh its costs?

The discussion above shows that the answer to many of these questions is "no." Project 25 is not a solution for an urban system that needs extra capacity now. Widespread adoption of Project 25 conflicts with the technological assumptions underlying the PSWAC report — and widespread adoption cannot be counted upon. The closed A interface locks agencies into getting upgrades from the original supplier. No major manufacturer, except Motorola, has committed to supply Project 25 equipment. At least one (and probably more than one) of the firms that are frequently described as Project 25 manufacturers is more properly characterized as a Motorola OEM.

ATTACHMENT A

Quick response: new digital mobile systems will allow emergency services to relay video images via walkie-talkie

War of waves

Andrew Baxter looks at two mobile digital systems vying for control of the new generation of networks

You are a police officer on the street, confronted by a suspected criminal. Using your video camera and a radio, you transmit a video image to your control room and seconds later receive confirmation of his identity.

Or maybe you are running a big city bus system. There has been an accident at an intersection, so you send data messages to terminals at bus stops warning prospective passengers of delays.

These are the kind of uses that emergency services, utilities and public transport companies are expecting from a new generation of digital private mobile radio systems. Over the next few years, they will replace the crackly voice-only analogue systems which these services have relied on for decades.

"A fireman could receive building plans over the radio or send a video back to base," says Jeremy Snowdon, chief electronics engineer for the States of Jersey. Since March, it has been testing a new digital system called Dimetra, (Digital Motorola European Trunked Radio), which Motorola launched amid the obligatory dry ice and flashing lights this week.

The launch is a big step forwards for the digital systems, as Dimetra is the first range to conform to the so-called Tetra (trans-European trunked radio) standard, which is in the final stages of approval by the European Telecommunications Standards Institute. "In a standards environment, he who is first wins," says Jonathan Paget, European general manager of Motorola's radio network solutions group.

The Dimetra range will begin its "phased roll-out" next summer, but Motorola will not have the market to itself. Other companies, including Nokia of Finland, are likely to introduce Tetra-based products. And with the launch of Dimetra, the gloves are off in a bitter turf war between supporters of Tetra and proponents of Tetrapol. This is a rival digital system championed by France's Matra Communications and is already on sale. The two systems can work together, but only on a limited basis, which will disappoint authorities battling cross-border crime.

The new digital systems have been developed because of a general recognition that conventional cellular networks could not meet all the needs of security forces, emergency services, and civilian users such as bus operators.

Users will be able to connect equipment such as barcode scanners and video cameras to their mobiles. Police forces get special emergency buttons on their portables and their radio messages encrypted. In some systems, large numbers of users can listen simultaneously to an operator's instructions. "Direct-mode" calls can also be made from mobile to mobile, without passing through the infrastructure, which would be impossible in a cellular network.

Tetra uses a process known as Time Division Multiple Access, in which several simultaneous calls are each given a time slot within one 25KHz-wide radio channel. In contrast, the Tetrapol system and a US standard called APCO 25 use Frequency Division Multiple Access in which each call occupies a narrower, 10KHz or 12.5KHz, chunk of the frequency.

Engineers argue endlessly about which system is better for private mobile radio systems, says Paget. Motorola says the time division process is more flexible due to the wider bandwidth, and says the batteries in the portables last longer. Also, it says, duplex conversations (both ends of the conversation talking at once) are more difficult on a frequency division system.

The latter's supporters say the system is better suited for large networks with few users, such as a police network. "With a large network, FDMA drastically reduces the number of base stations, cutting the cost of the infrastructure," says Hubert Azemard, president of the Tetrapol Forum, which groups Matra, foreign-owned subsidiaries, and allies including Bull and Nortel. Also, he says, it works better in hilly terrain and cities, and is much easier to use for simulcasts or group-wide messaging.

The two sides' perceptions of their own market positions are poles apart. With 13 principal customers in Europe, Asia and the Middle East – including the French gendarmerie's Rubis network and the French national police's fledgling Acropol network – Tetrapol has become a *de facto* standard, says Azemard.

That is not how Motorola sees it. "The Matra system is not a standard . . . they are brilliant at marketing it as a standard, but it isn't," counters Paget. "Tetra is the solution which a majority of countries, manufacturers and users are vigorously supporting, and Matra is very much out on a limb." Things seemed to be moving in Motorola and Tetra's direction last month when the Tetrapol Forum said it had temporarily suspended a process of turning its technology into an Etsi standard. Motorola gleefully called on Matra to throw in the towel.

But the Tetrapol side intends to come back in a few months to win official recognition. "More and more regulators are sure that the two technologies need to be available in Europe," says Azemard. In particular, he claims, some 70 per cent of the overall PMR market is using narrowband 12.5KHz radio: "Users who want to migrate from analogue to digital will have to migrate in the frequency band they have."

The next three to four years could produce more than $1bn (£606m) of orders for digital systems in Europe, and so far Motorola has just one small contract for a Tetra system, from Oslo airport. But the US company believes Tetra technology will pick up the big nationwide system orders that are in the offing. "People have been waiting for Tetra," says Paget. "It will lead to an explosion of sales."

Azemard, meanwhile, remains confident. "Why should we not be?" he says. "We are four to five years ahead of Tetra."

TETRA - THE DIGITAL PMR REVOLUTION

Key Features & Benefits

Without doubt the proposed TETRA digital radio standard represents one of the most exciting opportunities for PMR this decade - and the future path will lead to a new golden era in radio communications.

The launch of TETRA, European Private Mobile Radio (PMR) will begin the process of moving towards totally digital communications based networks. These radio systems of the future will be substantially different from today's, using spectrally efficient digital radios offering significant performance enhancements.

TETRA is the digital standard for trunked radio developed by the European Telecommunications Standards Institute (ETSI) to serve a wide variety of user requirements in the Emergency Services, Utilities, Transportation, Defence, Municipalities, Public Trunking and Industrial Markets.

The principle functionality and benefits afforded by TETRA include:

* Digital Speech
  State-of-the-art digital speech coding and error protection ensure high quality voice which remains relatively constant over the whole coverage area, unlike analogue voice which degrades with increasing distance from the base station.

* Spectral Efficiency
  TETRA uses $\Pi/4$DQPSK, a digital modulation particularly robust to the harsh conditions of mobile radio propagation, to support four voice channels and/or data rates up to 28.8kbit/s in a 25kHz bandwidth.

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* TDMA Technology
  TETRA flexible bandwidth assignment for data services, fast pre-emption, automatic RF power control as well as simple to implement handover and full-duplex operation.

* Functionality
  TETRA supports comprehensive circuit and packet mode data services as well as voice. There are currently standards for up to 30 supplementary services such as priority call, call authorised by dispatcher and call forwarding, although only nine of these are likely to be available initially.

* Security
  TETRA offers secure voice and data services as well as encryption of signalling incorporated as part of the standard.

* Inter-operability
  TETRA will allow mobiles to roam within and between TETRA systems, allow different TETRA systems to be interconnected and different types of terminal (mobile and line connected) to interwork and have access to exactly the same set of features. Currently standard interfaces are being defined to connect TETRA systems to PSTN, PSDN and ISDN systems.

* Choice of Supplier
  Standardised services and well defined intra and inter-system interfaces means that inter-operability will be possible between equipment from multiple suppliers.

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ENHANCED TECHNOLOGY

TETRA utilises Time Division Multiple Access (TDMA) techniques to provide four simultaneous and independent communications paths over one RF carrier pair in a 25KHz RF channel bandwidth. The use of TDMA technology provides unique facilities not previously available on Frequency Division Multiple Access (FDMA) analogue FM systems.

This holds several advantages for operators such as less space and weight required at base station sites, reduced antenna combining requirements and less power consumption. This translates into financial benefits including reduced equipment costs, lower installation costs, lower site rental costs and reduced life cycle costs.

TETRA's mode of operation facilitates full duplex capability thereby allowing a simplex radio to provide duplex voice or data capabilities. This also means that radio equipment can be made smaller and more portable; no antenna duplexer is required for simultaneous transmission and receiver operation, and handsets can offer simple telephone type operation in a mobile radio environment.

As well as giving operational flexibility and cost effective duplex operation, TETRA will provide improved operational efficiency by extending mobile radio communications into PABX/PSTN networks.

Simultaneous voice and data transmission will be one of the main selling points for TETRA and will be readily available to system users. Data and voice messages will be sent and received on the same radio without contention and via simple user interfaces.

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The other major advantage of TETRA technology is that it offers bandwidth on demand. One, two, three or all four of the time slots can be used to send and receive data. This allows practical use of slow scan video, digital mapping, image transmission and other high speed data applications.

In summary, Carol Tweten, Director of TETRA for Motorola Radio Network Solutions Group, said: "The power and flexibility of digital radio will redefine how we look at communications. As the new systems go into service, we will take a significant step into the future. The rules we use to define how our communications systems operate and the performance we expect from the are going to change.

"Digital audio quality will be better across larger coverage areas. The capacity for signalling and control will dramatically increase and with this increase will come new features. TETRA will improve spectrum efficiency and will address the evolving reaffirming initiatives. Digital standards will facilitate inter-operability between digital radios and multiple sources of digital equipment.

"In effect, TETRA will offer a new platform for the rapid deployment of multi-functional communication devices which will positively impact on the way in which emergency services and utilities are delivered and supported across Europe and many other parts of the world."

- ENDS -

MOTOROLA RNSG
TETRA QUESTIONS & ANSWERS

What significance does Motorola place in TETRA?

TETRA is the most important initiative this decade in Europe for Private Mobile Radio (PMR). Historically, Europe has been a fragmented market for PMR: different frequencies, different type approval criteria and different signalling protocols. This has resulted in an inefficient market for both user and supplier. The user suffered from a limited choice of supplier and technology and, in some areas, excess cost due to limited volumes. For suppliers this has meant excessive development costs and many obstacles to developing an efficient Pan-European market.

TETRA has the potential to change all this. Harmonised frequencies, signalling and type-approval processes mean that TETRA will generate a genuine Pan-European market. Suppliers that invest in the standard can obtain an appropriate return. But the real winners will be the users. They will benefit from the most advanced communications features and capabilities that this new technology can provide.

What are the strengths of Motorola's TETRA strategy in Europe?

We have access to technology platforms that have previously been developed elsewhere in the world. We decide in Europe how to engineer the solution and then our engineers execute that solution. Engineering teams in Denmark, the UK and Israel are able to develop those platforms to meet the customer needs within Europe, based on the TETRA specification.

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For example, we have many years of experience with wide-area trunked solutions for Public Safety organisations. These systems offer from city wide to country wide coverage and provide an enormous amount of practical feedback in terms of the structure and features for a TETRA system. We have installed major communication systems for the Danish Police, Portuguese Police and, more recently, the South African Police and the London Metropolitan Police.

What are the principle benefits afforded by TETRA?

State-of-the-art digital speech coding and error protection will ensure the same high quality voice which remains relatively constant over the whole coverage area, unlike analogue voice which degrades with increasing distance from the base station.

TETRA will allow mobiles to roam within and between TETRA systems, allow different TETRA systems to be interconnected and different types of terminal (mobile and line connected) to interwork and have access to exactly the same set of features. Currently standard interfaces are being defined to connect TETRA systems to PSTN, PSDN and ISDN systems. Standardised services and well defined intra and inter-system interfaces means that inter-operability will be possible between equipment from multiple suppliers.

Although based on proven PMR and communications technology, the man/machine interface units which will be available before the end of this century will represent a dramatic leap in terms of operation and functionality.

Almost every possible business that involves a large number of staff dispersed over a designated area could utilise TETRA to improve productivity and efficiency. From utilities, delivery services, construction sites, factories and sales forces - the ability to send and receive written information as well as voice, wherever and whenever, is immense.

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Is there scope for further integration?

The future will provide numerous options for even more data services utilising the same radio system infrastructure and user equipment via a standardised radio data port to allow the connection of external devices such as bar code and plain text readers, or computer terminals.

Indeed many software and hardware manufacturers are already developing accessories to enhance the capabilities and applications of tomorrow's radio equipment.

Other technologies that could be easily integrated into TETRA radios include:-

- *Vehicle location*
  This application will be easy to integrate into public safety communications. The system will function with many types of location systems, one being satellite based systems such as the GPS - Global Positioning System.

- *Facsimile*
  This application is identical to that commonly provided by the land line today.

- *Still Picture*
  A still picture or snapshot is a service which goes beyond that of basic fax. It provides a much higher level of resolution, grey scale or even colour and could provide a much higher content of non-alpha numeric information.

- *Slow Scan Video*
  Providing high resolution colour images at modest frame speeds, this would provide information for real time applications. This application would require high resolution, colour and a scan rate of at least one frame per second.

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So, how can these applications become a reality?

Standardisation is the key. TETRA can only succeed in achieving its potential in terms of economy and benefits if it has the full backing of manufacturers, operators and legislative bodies.

With mobile communication markets booming and demand for frequencies escalating, it makes sense that effective pan-European spectrum planning should also incorporate dedicated frequencies for digital PMR systems.

Indeed, a standard common interface is essential and should address the needs of public safety and municipalities plus energy, rail, transportation and other PMR users.

It is likely that the first products for TETRA will be in the 380-400 MHz band for emergency services. At first this may appear exclusive to Europe but, on investigation, 380-400 MHz could be made available to several countries outside. Also, 410-430 MHz for civil use appears to be the next viable allocation for business use.

Many manufacturers, including Motorola, anticipate that, once TETRA is operational and a few major systems are established, then users will quickly jump on board the bandwagon.

How can the need for autonomy be satisfied by a single digital trunked PMR system such as TETRA?

The answer is the partitioning of communications resources within a TETRA system to make it a virtual network. For example, each subscribing agency would be able to control their own resources independent of any other agency as if it was their own system.

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Even though the TETRA system hardware (base stations, antennas, controllers, switches, etc.) would be the same equipment serving all subscribers, autonomy would be achieved through 'software' partitioning. With the use of suitable password protection, a subscribing emergency service would be able to control their own resources without fear of losing them to another emergency service.

The provision of communication resources (such as channels, coverage, GOS, number of radio units, facilities, etc.) would be determined in the planning stages of the PSRCP. The third party operator of the shared system would be contracted to provide the required communication resources for each subscribing emergency service. All the third party operator would require is network access for traffic information and usage of the different facilities for each subscribing emergency service. This information would be needed for the purpose of billing and overall network performance and management. The third party operator would be prevented from monitoring voice or data traffic thereby ensuring autonomous operation and security for each subscribing emergency service.

It is important to note that a third party operator, such as that envisaged by the PSRCP, would be motivated to provide a reliable system satisfying the needs of its customers. It will have no alliance or affiliation to any of the subscribing emergency services and could even be monitored/regulated by an independent government body to ensure contracted performance and security criteria are met.

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What is so special about trunking that cannot be satisfied with existing conventional systems?

Because a trunking system shares a relatively small number of channels equally amongst a relative large number of users, the number of radio users that can be supported on a trunked system compared with a conventional system is far greater (assuming same Grade of Service). This is why trunking is more spectrum efficient.

Another benefit is that trunking systems have a control channel which is accessible all the time. This means that emergency calls will always get through even when all voice channels are in use. In addition, there is no need to have main/standby base stations on a trunked base station site because if one base station fails communications are covered by other base stations in the same trunking pool. In busy periods all that would be noticed is a decrease in the Grade of Service (GOS) until the faulty base station is repaired or replaced.

What is so special about digital trunking that cannot be satisfied with existing analogue trunking systems?

There are two main advantages of digital trunked PMR communication systems when compared with analogue trunking, these are constant voice quality over the RF coverage area and voice security. Trunking has the same advantages whether digital or analogue.

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